Appendix 2. R&D Program

W. Chou

A2.1. R&D for a Synchrotron-based 8 GeV Proton Driver

The R&D required to build the Proton Driver has been discussed in PD1 (see Chapter 19 of Ref. [1]). In that study, the R&D is divided into three categories. Category A includes those items that are not only needed by the Proton Driver but will also be useful for improving the performance of the present proton source. Therefore, they have the highest priority. Category B is the R&D work that is critical to the Proton Driver and is currently underway (partially supported by the US-Japan Accord for Joint R&D on High Intensity Proton Facilities). Category C lists other R&D items that are necessary for the Proton Driver but may have to wait until more resources are available. This itemization of R&D items is still valid for PD2. Although several major design parameters in PD2 differ from PD1, most R&D items are the same with only a few exceptions. For example, the stranded conductor coil study is no longer needed due to changes in the magnet design. Here we highlight those R&D items that should be given high priority:

- <u>Booster 53 MHz rf cavity modification</u>. Enlarge the central pipe aperture from 2-1/4-inch to 5-inch and increase the voltage per cavity from 55 kV to 66 kV. These modifications would also benefit the present Booster. This work is making good progress (see Chapter 5.1).

- <u>Space charge study in the present Booster.</u> A study group has been formed for this purpose. It consists of experts in theoretical modeling, computer simulations and machine experiments. Several physicists from the Oak Ridge National Laboratory and Rutherford Appleton Laboratory have also joined this study.

- <u>Inductive inserts study in the present Booster</u>. From the experience at the PSR at Los Alamos National Laboratory and simulations on the Proton Driver as well as on the Booster, it is expected that inductive inserts would effectively reduce the potential well distortion due to space charge and thus reduce beam losses at high intensity. Two ferrite modules, each one-meter long, were installed in the Booster. No adverse effects have been observed on the beam. It is planned to install 8 more modules during the next scheduled machine shutdown in October 2002.

- <u>Booster magnet dc and ac field measurement in E4R</u>. A test stand has been set up in the E4R area. It has two spare Booster magnets and a 15 Hz resonant power supply. Two measurement techniques have been employed. One uses a stretched wire. Another uses a rotating coil (a mole). The data will be compared with those from machine experiments (e.g., chromaticity measurements).

- <u>Dual resonance power supply test in E4R.</u> It is planned to add another choke and another capacitor to the 15 Hz resonant power supply to add a 12.5% 30 Hz component to the magnet current waveform. The would lead to a 25% reduction in maximum dB/dt. Since the peak rf power is proportional to dB/dt this is then also reduced.

- Linac front-end improvements. These include the development of high brightness H^- sources (i.e., producing high intensity low emittance beams) as well as a 200 MHz RFQ. Both are described in detail in Chapter 13 of Ref. [1].

A2.2. R&D for the Main Injector Upgrade

Since the Main Injector is an existing machine, R&D on it can be performed as Accelerator Improvement Projects (AIPs). Each successful R&D project will improve the MI performance. Here we list those R&D projects specified in this PD2 study.

- Gamma-t jump system. This system has been designed. R&D is required to fabricate a prototype triplet (two 0.5-m and one 1-m quadrupoles), a pulsed power supply and several Inconel pipes, and to carry out magnetic field measurements.

- Dual power amplifier rf system test in MI-60. This is a major part of the R&D in the MI upgrade. There is no experience in operating an rf cavity using two amplifiers. It must be tested. Furthermore, the reliability of the Y567B tetrode operating at 800 kW at high duty cycle is also an untested territory. To ensure this scheme will work, an rf test stand in the MI-60 building for this study should be a high priority item.

- Large aperture quadrupoles (LAQs). A 4-in. LAQ needs to be fabricated and its field measured. Because these LAQs will be on the same bus as the regular quadrupoles, the fields must track each other during the ramp.

- Large aperture kickers. There is on-going R&D to use PEEK pipes replacing the ceramic ones presently used for the kickers. This would increase the vertical aperture from 1.3 in. to 1.6 in. However, this is not enough. The goal of this R&D needs to be aimed at a 2-in. aperture, the aperture of the beam pipe in the Main Injector. Both PEEK and ceramic materials will be investigated.

- Collimators. The design of a 2-stage collimation system is presented in this report (Ch. 19.2). The primary and secondary collimators need to be manufactured and installed in the MI ring for a beam test.

- Passive damper and active feedback. A spare MI rf cavity will be used for a passive damper experiment. Active feedback is an on-going activity and will continue.

References

[1] "The Proton Driver Design Study," FERMILAB-TM-2136. (December 2000)